#00-06 (Nov-Dec 0

EUROGRAM

EUROPEAN OFFICE OF AEROSPACE RESEARCH AND DEVELOPMENT

CC HIGHLIGHTS

EOARD has completed one of our best-ever years supporting AFRL international efforts. In fiscal year 2000, EOARD organized a near-record 256 Window on Science visits, and broke records for conferences supported (87) and research contracts awarded (132). I want to recognize the hard work and dedication of our program managers and support staff. Special thanks go to our Contracting Officer (Mrs. Candy Lindsly), Finance Staff (Mrs. Barbara Murphy and Mr. Chuck Short), Window on Science Support Services (Mrs. Stephanie Brewis), and Database Support (Mr. Nigel Jones). Thanks to all, including our customers, for a tremendous year!

The above numbers include 50+ research contracts placed through the International Science and Technology Center (Moscow) and the Science and Technology Center of Ukraine (Kiev). Several EOARD staff members journeyed recently to Moscow to meet with the ISTC staff and work to streamline our contracting process with them. Contact your technology area program manager for details.

EOARD welcomes a new group into the Engineer and Scientist Exchange Program. This year's ESEP includes seven officers and one civilian from various Air Force Research Lab locations, the USAF Academy, and McClellan Air Force Base. Details about their assignments in Sweden, Israel, Germany, and France can be found in the feature article.

We say farewell to Mr. Peter Ouzts, our first NASA co-located program manager. Peter will return to NASA's Glenn Research Center in Cleveland Ohio. EOARD welcomes Dr. Edward Feigenbaum, former Air Force Chief Scientist, as a Visiting Scientist. Dr. Feigenbaum joins us on the first of November.

For the Commander

Robert S. Fredell, Lieutenant Colonel, USAF
Technical Director, EOARD

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Abstract EOARD has completed one of our best-ever years supporting AFRL international efforts. In fiscal year 2000, EOARD organized a near-record 256 Window on Science visits, and broke records for conferences supported (87) and research contracts awarded (132). I want to recognize the hard work and dedication of our program managers and support staff. Special thanks go to our Contracting Officer (Mrs. Candy Lindsly), Finance Staff (Mrs. Barbara Murphy and Mr. Chuck Short),	
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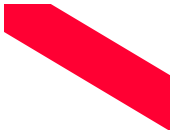
Feature Article

Engineer and Scientist Exchange Program (ESEP)
EOARD Welcomes New International Engineers and Scientists

Seven officers and one Air Force civilian have begun new Engineer and Scientist Exchange Program (ESEP) assignments in Europe this fall. The Air Force Office of Scientific Research administers the Air Force's Engineer and Scientist Exchange Program (ESEP) for the Deputy Undersecretary of the Air Force for International Affairs (SAF/IA). ESEP involves a formal exchange of bright, young government researchers between participating countries. Established over thirty years ago by Defense Secretary Robert MacNamara, ESEP is a career-broadening assignment for military and civilian government scientists and engineers. As part of ESEP, these engineers are able to learn close-up different approaches to basic research outside the United States.

The US typically sends its participants for two-year tours. Reciprocating countries tend to send a greater number of participants to the US for shorter assignments. Host research agencies offer positions for ESEP participants and the administrative offices in both countries cooperatively make the best matches for placement. If necessary, US personnel assigned to foreign laboratories through ESEP attend six months of language training, typically at the Defense Language Institute in Monterey, CA, prior to their move overseas.

During their tours, the participants are treated as full employees of their host agencies, although security concerns may impose certain restrictions. The Air Force has benefited not only from the expertise of the foreign scientists, but from its strong commitment to provide the majority of US participants. Inquiries regarding possible future participation should be directed to Dr. Jerry Franck at AFOSR/NI (703-696-7316, jerome.franck@ afosr.af.mil). EOARD provides administrative support (TDY orders, Performance Reports, etc.) to the exchangees while they are in Europe.

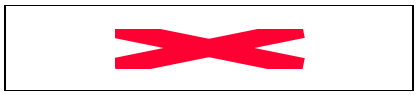


Major Matthew Bohn and *Captain Brian Quillen* are assigned to the German Aerospace Center (DLR) Institute of Technical Physics in Stuttgart, Germany. Matt Bohn comes to DLR from the Mathematical Sciences faculty of the US Air Force Academy. An optical physicist, Matt's project researches beam quality of mid infrared optical parametric oscillators. Brian Quillen's previous posting was as a Chemical Engineer at AFRL's Directed Energy directorate at Kirtland Air Force Base, New Mexico. Brian's project is Chemical Oxygen Iodine Laser (COIL)Enhancement.

Captain Richard Branam is assigned to DLR at Lampholdshausen near Heilbronn. Captain Branam's previous assignment was to AFRL's Propulsion Directorate at Edwards Air Force Base, California, where he managed the Upper Stage Demonstration Program. An aeronautical engineer, Rich's work will involve characterizing and understanding combustor injection environments at supercritical conditions using

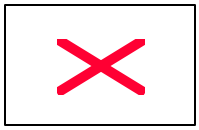
computational fluid dynamics. He will also develop methods for quantifying qualitative visual measurement techniques such as Schlieren flow visualization and Raman imaging.

Captain Richard Salasovich is also assigned to DLR, at Cologne. His background is in space propulsion from the AFRL Propulsion Directorate at Edwards Air Force Base, California. Captain Salasovich has dual Master's degrees, in Aeronautical and Electrical Engineering, both from the University of Cincinnati. His project will work to integrate various portions of the European Space Agency's Rosetta Lander project. The Rosetta Lander is slated to rendezvous with and land on a comet in orbit around the sun.

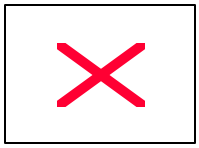


Captain Derek Ebdon is assigned to the Office National d'Études et de Recherches Aérospatiales (ONERA) in Toulouse, France. Captain Ebdon's previous assignment was as an aeronautical structures engineer at the Aircraft Battle Damage Repair program office at McClellan Air Force Base, California. His project with ONERA is investigating Active Aeroelastic Control to precisely control a torsionally flexible wing to optimize its aerodynamic performance while employing the wing as a primary lateral control device, reducing wing weight and extending aircraft range.

Dr. Chris Sturgis works at ONERA in Palaiseau, near Paris. Dr. Sturgis, who arrived from the Air Force Research Laboratory (AFRL) Propulsion Directorate at Edwards AFB, is researching heat transfer in internal cooling channels in turbomachinery. His primary emphasis will be on producing high-quality temperature measurements to support concurrent computer code development. Chris has a Ph.D. in Mechanical Engineering from Purdue University, earned under the Palace Knight program.



Major (Dr.) Jim Solti is assigned to the Swedish Aeronautical Research Institute (FFA), in Bromma, near Stockholm, Sweden. Major Solti was an Associate Professor of Engineering Mechanics at the US Air Force Academy before joining ESEP. Jim's research will investigate the structural response of impact-damaged resin-matrix composites and develop analytical models to predict their long-term behavior. Jim's Ph.D. is from the Air Force Institute of Technology.



Captain Matt Yocum is assigned to the Technion Israel Institute of Technology, where he is researching The application of piezoceramics to the control and elimination of vibration from aircraft structures. Captain Yocum's previous assignment was as Assistant Professor of Engineering Mechanics at the USAF Academy.

One ESEP participant is assigned to Australia. Mr. Larry Lewis of the AFRL Munitions Directorate, Eglin AFB Florida, works with the Defence Science and Technology Organization (DSTO) in Salisbury.

PROGRAM MANAGER REPORTS

Dr. Charbel Raffoul
Aeronautics

Conference: **The European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2000), Barcelona, Spain, 11-14 Sep 2000.** More than 1200 contributers from 54 countries gathered at the conference halls of the World Trade Center of Barcelona to exchange their expertise and to present research findings at the European Congress on Computational Methods in Applied Sciences and Engineering, ECCOMAS. During the four days of the congress there were lectures and regular sessions involving Computational Solid and Structural Mechanics, Computational Fluid Dynamics, Computational Mathematics and Numerical Methods, Computational Chemistry and Computational Electromagnetics.

Of particular interest were the sessions "Affordable parallel CFD on clusters" and "Shock wave-laminar boundary layer interactions and laminar separation at hypersonic velocities."

- **"Affordable Parallel CFD on Clusters"**

This invited special session was organized by Gulcat of Istanbul Tech and Ecer of Purdue. More than 40 attendees heard seven papers focused on numerical solutions of fluid flows with affordable high-perforformance computing.

- Professor Gulcat presented "Explicit and Implicit Parallel Solutions of 3-D Navier-Stokes equations on WS clusters" and discussed accurate and efficient, with super-linear speed-up, parallel solutions of incompressible and complex viscous flows.
- D. R. Emerson presented "Parallel CFD on commodity processors". He emphasized the portability of the codes originaly developed for the High Performance Computers like Cray T3D and T3E and made easily accessible for PCs and network items. A large number of processors encountered major speed-up problems.
- The paper given by H. U. Akay on "Dynamic load balancing applications on a heterogeneous Unix and NT cluster" emphasized the task of redistribution, whenever necessary, for the heterogenous clusters where load balancing is a major concern.
- "Parallel computation of influence wave modes for multi-passage cascade flows" by Tuncer discussed the flow characteristic change of a cascade flow due to an oscillating thin turbine blade under heavy aerodynamic loading. Here, the 'Linux' cluster was utilized for highly efficient parallel computation of the flow field.
- The paper "On a parallel simulation of a 3-D flow of viscous incompressible fluid" by M. Garbey described the effect of overlap size in the parallel grid and the sweep direction on the convergence rate of iterations due to domain decomposition.
- The last two papers were on the "Parallel supersonic viscous gas flow simulation on unstructured meshes" by B. N. Chetverushkin, and "Low cost computing in casting industries" by P. Adamidis. The former involved the pressure oscillations in 3-D open cavity flows at different flow angles and the latter was on the front tracking problems of casting flows computed on clusters.

- **"Shock Wave-Laminar Boundary Layer Interactions and Laminar Separation at Hypersonic Velocities"**

This session was chaired by Dr. Mikhail Ivanov from the Institute of Theoretical and Applied Mechanics (ITAM), Novosibirsk, Russia and was devoted to numerical simulations of hypersonic separated flows over concave bodies with sharp leading edge, i.e. hollow cylinder flare. Special attention was paid to the problem of agreement between results obtained using different Navier-Stokes solvers, grid convergence, and comparison with DSMC and experimental results.

In order to obtain grid convergence of the results, it was shown that the Navier-Stokes solver requires a very fine grid (about 600x400 points). It is worth noting that accounting for slip conditions is important for prediction of laminar separation in flows with rather high Reynolds numbers (about 2x10^4). However, the difference with DSMC results is observed even if slip conditions are taken into account for the Navier-Stokes solver. A significant difference with experimental results is still observed for Navier-Stokes and DSMC codes. The DSMC results presented by Dr. Jim Moss (NASA Langley) have shown the need for further study of the problem of laminar hypersonic separation flows by continuum and kinetic approaches. More detailed experimental investigation of this problem is also necessary.

The Book of Abstracts, about 1200 papers, was published and given to the participants during the registration. A CD that contains full papers was also made available. The next CFD conference for ECCOMAS will be held at Swansea, UK in September

2001 and the next joint congress of ECCOMAS will be held in Finland in the Summer of 2004.

Conference: **The 8th European Turbulence Conference (ETC8), Barcelona, Spain, 27-30 Jun 2000.** Contributions by 273 scientists from Europe and the Former Soviet Union (FSU), 73 from the Americas, 29 from Asia, 9 from Australia and 3 from Africa were presented orally or as posters. All aspects of current turbulence research were addressed, covering purely theoretical to purely applied research. Specifically, flow instability and laminar-turbulent transition, direct numerical simulation (DNS) / large eddy simulation (LES), geophysical turbulence, intermittency and scaling laws of turbulence, vortex dynamics, flow control, magnetohydrodynamics (MHD) and turbulence modeling were presented.

From the numbers, the talks generated the impression that DNS and LES, which emerged as research tools in the past two decades, have matured into complements/alternatives of experimentation in identifying turbulent flow physics in complex configurations. Prime examples of this were the invited lectures of Moin *et al*. (Stanford) on LES of turbulent premixed combustion and Jimenez (Madrid) on open computational problems in wall-bounded turbulence. The subgrid-scaling (SGS) modeling issue appears to be closed since the presentation of accurate reproduction of DNS results by the LES SGS model of Stolz *et al*. (ETH-Zurich). In contrast, the current frontier in numerical fluid mechanics lies in the development of high-order accurate methods for the description of flows in complex geometries. Another positive development witnessed at ETC8 was the increasing level of competence of FSU scientists in numerical fluid mechanics (e.g. Kudryavtsev and Khotyanovsky, ITAM Novosibirsk). Of interest also was the contribution of Reau & Tumin (Tel Aviv) in applying novel linear instability techniques to the analysis and accurate prediction of turbulent flow fields. From an experimental point of view, Wygnanski *et al* (Tel Aviv and U. Arizona) presented effective means of (airfoil) separated flow control, based on a global frequency that scales with the length of the recirculation zone. Of interest also were the presentations by Estevadeordal *et al*. (Wright-Patterson AFB) on measurements of interactions of three-dimensional global instabilities in plane mixing layers and global vortex instabilities. Flow instabilities and laminar-turbulent flow transition were addressed in a series of talks. The presentation of global linear instability theory by Theofilis (Cranfield & DLR-Göttingen) was of particular interest. Dr. Theofilis discussed a theoretical approach for the identification of residuals in flow simulations as global flow instabilities. He also discussed an algorithm for the drastic reduction of computing effort in recovering two- and three-dimensional steady-state fluid flow solutions from transient simulation data (work supported by EOARD-Contracts F61775-99 WE049 and WE090).

Sufficient time was provided during breaks and social events for discussions between the participants. The organizers have contributed to a successful event by devising an efficient internet-based information-dissemination scheme (URL: http://etc8.litec.csic.es link active as of Sept 28, 2000).

Conference: First European Forum on Ballistics of Projectiles, Saint-Louis, France, April 2000. The three-day First European Forum on Ballistics of Projectiles (EFBP) was organized by Institute Saint-Louis (ISL), France and co-sponsored by EOARD. The technical sessions included various national munitions programs (projectiles), internal ballistics and propulsion, launcher systems and launch dynamics, intermediate and exterior ballistics, terminal effects and vulnerability, sensors and instrumentation, and future trends and perspectives.

ISL is a world leader in rail gun accelerator research including the evaluation of high-g effects on electronic components. ISL is developing small on-projectile instrumentation packages accommodating accelerometers, pressure transducers, thermocouples, magnetic sensors, and either on-board transmitters or recorders for data collection and retrieval.

The UK and Germany also have active programs associated with electro-thermal-chemical (ETC) gun technology. This development is directed toward tank or self-propelled artillery systems.

Detailed discussions with Mr. Dupuis (DREV) and Dr. Berner (ISL) about the results of their wind tunnel tests of missile grid fins indicated unusual and rapidly varying aerodynamic effects especially in the pitching and yawing moments and hence the center of pressure. The data implied that the center of pressure would actually move ahead of the body. Some scientists believe this is an erroneous conclusion, because the wind tunnel balance cannot distinguish between the moment caused by the normal force and the moment created by differing fin drag components caused by the uneven flow through the opposing grid fins. Nevertheless this condition could cause severe

dynamic problems in pitch, yaw and roll resulting in dynamic stability anomalies.

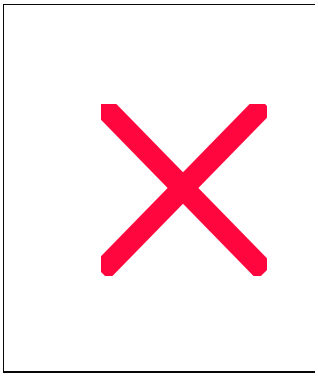
Mr. Fleck (ISL) discussed an on-board sensor ISL is developing to measure the position and attitude of a projectile using the Earth's magnetic field. If this sensor performs as described it would appear to have applications in the guidance and control of various munitions.

Col. Ron Reed
Life Sciences

Site Visit: International Science and Technology Center (ISTC), Moscow, Russia, 23-25 October 2000. During this visit by EOARD program managers and contracting personnel to ISTC, two areas were highlighted - biosciences and radio frequency technologies. The biosciences portion of the ISTC meeting was coordinated by Dr Diana Pobedimskaya [pobedimskaya@istc.ru], new Senior Project Manager in this area. The radio frequency technologies will be discussed in a future Eurogram by Lt Col Burns.

The ISTC facilitates host-government approval for cooperative research efforts in addition to providing administrative support and financial liaison between the United States and former Soviet Union scientists. The center can act as a liaison with scientists that our labs identify as potential collaborators and can act in a "matchmaking" capacity by introducing us to scientists they know in specific disciplines. On this visit, they did both while focusing on scientists and research institutes from the Moscow area. The focus of the formal presentations and discussions were biosensors, biomaterials, and biotechnology. ISTC did not include scientists with human factors or aircrew protection expertise; however, these scientists should be included in later meetings.

- **Prof Sveshnikov** (Deputy Director, Russian Research Center for Molecular Diagnostics and Therapy). Areas of primary interest include immunodiagnostics and hybridoma applications. New areas of interest include multi-array biosensors, as well as surface acoustic and magnetostatic wave biosensors.
- **Drs Fokin and Utkin** (State Research Institute of Organic Chemistry and Technology). Experience in the synthesis and destruction of a wide variety of organic compounds. Current efforts include applications in environmental and medical areas. They also are capable of work in biosensors, toxicology, and risk evaluation.
- **Dr Frontchek** (Central Scientific Research Institute of Chemistry and Mechanics). Converted their activities away from the development of explosives from organic substrates. They now are pursuing a variety of projects using chitin and chitosan polymers. These include medical preparations such as wound dressings, drug-delivery systems and cosmetology.
- **Prof Sevastianov** (Research Institute of Transplantology and Artificial Organs). Their focus is on understanding protein absorption and surface biophysics to make artificial structures compatible with blood and other human tissues.



They presented data on a self-assembling, mosaic nanostructure that acts as an interface between body fluids and artificial materials and have also explored using vacuum UV radiation to smooth surfaces.

- **Drs Il'in and Timofeev** (Institute of Biomedical Problems). This institute's primary focus has been on human space flight issues. They presented two main areas in which they solicit support. The first is developing waste-management systems, primarily optimal microbial populations for long-term waste recycling. The second is high-performance oxygen generation by absorptive or thermochemical means.
- **Dr Zolotarev** (Institute of Molecular Genetics). Broad capability to develop physiologically active substances (e.g., regulatory peptides), radioactively label them, and use them to track metabolic processes.
- **Prof Manelis** (Institute of Problems of Chemical Physics). Broad capability in polymers, composites, explosives, propellants, chemical and biological processes. Polymer production and testing includes organometallics and organic superconductors, as well as some nanomaterials.

They also do work in biosensor development and on the role of free radicals in biological processes or wound and disease states.

- **Dr Bachurin** (Institute of Physiologically Active Substances). Focus on low molecular-weight compounds: computer modeling, synthesis, study (e.g., as protective agents for radiation, stress, cancers, or neural damage), and their application to biosensors.
- **Dr Lukyanov** (Institute of Bioorganic Chemistry). Among other areas, this group is currently doing work on biochromphores and photochemistry in microbial and multicelled organisms. Their expertise lies in characterizing, modeling, and modifying chromophores.

EOARD can provide further information or liaison on work done by any of these scientists or institutes.

Conference: International Workshop on Medical & Engineering Aspects of Dynamic Head & Neck Injuries, Cranfield University, United Kingdom, 15-18 October 2000. The primary point of contact was the Cranfield Impact Centre with Paul Popely [p.d.popely@cranfield.ac.uk] acting as coordinator.

This workshop involved 50 attendees representing scientific, engineering, and medical communities from the United States, United Kingdom, Holland, Sweden, France, Greece, Canada, and South Africa. The meeting was sponsored by EOARD, the US Army, the US Navy, NASA, Federal Aviation Administration, National Highway & Transportation Safety Administration, and the United Kingdom's Defence Evaluation and Research (DERA). A letter of strong support for this multidisciplinary, multinational effort also came from Mr Christopher Reeve and the Christopher Reeve Paralysis Foundation.

Plenary presentations were given in the areas:

- "Impact of Repeated trauma from parachute landings" by Col John Powell (US Army Aeromedical Laboratory),
- "Automotive Biomechanics Perspective" by Dominic Cesari (INRETS, the French National Research Institute for Transportation and Transport Safety),
- "Military Aircraft Crash Perspective for Head and Neck Injuries" by Squadron Leader Matt Lewis (RAF Centre for Aviation Medicine), and
- "Development of Head and Neck Injury Criteria in Automobiles" by Hugo Mellander (for Priya Prasad, Ford Motor Company).

These presentations set a broad framework for looking at head and neck injuries in transportation accidents. They also highlighted unique issues and areas of overlapping interest.

The workshop was divided into five sessions, incorporating 24 presented papers and 6 discussion periods:

- Head and Neck Injury Trauma Mechanisms
- Injury Tolerance Levels
- Mathematical Modeling
- Diagnostic Techniques and Test Procedures
- Head-mounted Mass

Three rapporteurs recorded key issues, ideas, and impressions throughout the workshop. They presented their report, along with recommendations for further work, during a final discussion session. Their summary will be circulated to all attendees for final comments.

Participants recognized the unique needs of the aerospace environment, both fixed-wing and rotary-wing, as an area with special demands. Gender and issues of protecting smaller or larger occupants included those seen in military ejection seats, but also with infants in car seats or non-transportation accidents. Mr Steve Soltis (FAA) was especially interested in any new discussion of side-facing seats and lateral impacts that might relate to civil aviation safety standards.

Several presenters focused on the long-term effects of head trauma. Dr. Barclay Morrision (Southampton General Hospital, UK) showed *in vitro* research data on how mechanical stresses could change long-term gene expression in neural cells, particularly in genes related to cell survival or programmed cell death. This work related to the known "self-destructive cycle" of degeneration often seen in brain tissue over many months after even microseconds of trauma. Several other presenters broadened this discussion of long-term effects regarding the impacts of repeated trauma (as noted by Col Powell for parachute landings) or chronic loading (as with head-mounted mass, especially noted by Joe McEntire of the US Army Aeromedical Research Laboratory and Dr Karin Harms-Ringdahl from Karolinska Hospital, Sweden).

There was strong representation at the workshop from the mathematical modeling community. Several of these

participants cited the need for basic data on *in vivo* neural tissue properties and biomechanics—data to support improved modeling efforts. Another area of needed data is in accident reconstruction. Several suggestions were made regarding the need for more complete data on accidents so that their effects could be better understood.

Speakers, including Dr Louise Carter from AFRL/HE at Wright-Patterson AFB, also discussed injury criteria. This area impacts modeling as well as the broader understanding of injury mechanism, the generation of safety criteria, and the development of protective systems.

Overall, there was a general consensus that a follow-on workshop should be held in 1½ to 2 years. In the interim, several participants (including Dr John Firth of Nottingham University Hospital, UK) expressed a strong desire for a more focused, international research effort in this area.

Dr. Chris Reuter
Information Technology and C4I

Workshop Announcement: 'Mathematical Methods, Models and Architectures for Computer Networks Security', May 21-23, 2001 in St. Petersburg, Russia. See the conference web site for the Call for Papers, Topics, and Registration information (http://space.iias.spb.su/mmm2001). The workshop will provide an environment conducive to personal interaction between leading researchers working in all aspects of information technology security including problems related to information processing, storage, and retrieval on large-scale computer networks. Sessions will be designed around three main topics:

- Mathematical Methods and Models of Security Systems,
- Advanced Information Technologies for Computer Networks Security, and
- Applied Network Security Systems.

Springer Verlag will publish the Conference Proceedings in their series "Lecture Notes in Computer Science".

Site Visit: University of Strathclyde, Glasgow Scotland, 30 Aug-1 Sep 2000. Drs. Patrick Nixon and Richard Connor in the Department of Computer Science discussed their research related to ad-hoc distributed computer networks. Ad-hoc dynamic mobile computer networks such as a cluster of portable PCs with wireless ethernet are becoming increasingly viable and may provide reliable, fault-tolerant, un-interruptible information services to satisfy the Air Force's distributed information management needs. However, to operate effectively and efficiently, such a dynamic mobile network must address issues such as load sharing, communication performance, reconfiguration, and node availability. These issues are being addressed by these researchers.

Dr. Michael Grimble is the Director of the Industrial Control Center of the Department of Electronic and Electrical Engineering. The EEE Department is the largest in Scotland and one of the largest in the UK. It boasts a long tradition of engineering excellence, while the Industrial Control Center is internationally renowned as a world-class research center with a highly rated postgraduate education program. Their proven techniques have seen application in the aerospace (e.g. robust adaptive non-linear flight control), marine and numerous other industrial control applications.

Site Visit: St. Petersburg Institute For Informatics & Automation of the Russian Academy of Sciences (SPIIRAS), Russia, 6 – 10 July 2000. A group from AFRL/IF joined a combined AFOSR/ EOARD team visiting Russian research institutes with advertised research expertise in Information Technology, Lasers and Holography, and Microwave semiconductor switches. Team members included Dr. Joseph Janni, Col. Steven Reznick, Dr. Lyle Schwartz, Dr. Jack Agee, and Dr. Yolanda King of AFOSR; Dr. Barry McKinney, Dr. Leonard Popyack, and Mr. Joseph Turczyn of AFRL/IF; and Dr. Roy Phillips, Dr. Charbel Raffoul, and Dr. Christopher Reuter of EOARD.
SPIIRAS is the Russian Center of Excellence for Information Technology. The meeting was hosted by General Director, Prof. Rafael Ioussoupov (*yusupov@iias.spb.su*) and Dr. Irina Podnozova, Assistant to the Director for International Research Cooperation (*ipp@mail.iias.spb.su*). The meeting focused on new areas in Command and Control and Information Assurance. Specific topics included multi-agent systems for network attack detection, cognitive system approach for command and control, knowledge fusion, mobile code, data mining, and advanced 3-D visualization.

Current capabilities: Their present staff of 25 senior-level Doctors of Sciences advises more than 50 Ph.D. candidates and sponsors additional post-graduate level

research. An interesting new area is specialized computational devices based on mechanisms of immune networks for information processing applications. This is highly effective in problem solving for pattern/image recognition and risk evaluation. Highlights of more traditional IT research include: multi-agent systems for distributed planning, scheduling, and operational control under uncertainties; computer speech understanding for dialogue systems and control; systems for recognition of printed and handwritten texts; virtual reality, guidance, control; and knowledge discovery. They also do work with computers having dynamic architectures to support real-time problem solving for radar information processing and telecommunication networks. SPIIRAS has many professional links with Russian, CIS (Commonwealth of Independent States), and foreign public and private organizations (e.g. Ford, Motorola). They frequently participate in bilateral exchanges of scientists.

History: SPIIRAS was founded in 1978 by decree from the Council of Ministers of the USSR out of the Computer Science Department of the Ioffe Physical and Technical Institute (the largest institute within the Russian Academy of Sciences). First called the Leningrad Research Computer Center (LRCC), its name was changed to the Leningrad Institute for Informatics and Automation of the USSR Academy of Sciences (LIIAS) in 1985 upon creation of the "Academic Network", a global computer and information network. In 1992, when the historic name of St. Petersburg was returned to the city, LIIAS was renamed to SPIIRAS. By this time, it had grown into a large scientific research organization and several of its departments gave rise to new institutes within the Academy of Sciences. The current director, Professor Rafael M. Yusupov, Doctor of Technical Sciences, has headed the organization since 1991. SPIIRAS is the only research organization in northwest Russia operating under the Department of Informatics, Computer Science and Automation of the Russian Academy of Sciences.

Ms.Kathleen Zyga
Engineer and Scientist Exchange Program.

Editor's note: Kathleen Zyga is working at DSTO Adelaide, Australia under the Engineer and Scientist Exchange Program.

Conference: The Fourth International Conference on Knowledge-based Intelligent Information Engineering Systems and Allied Technologies, 30 Aug – 1 Sep 2000. With over 200 participants from around the world, a significant increase from last years attendance, KES '2000 was held in Brighton, UK. The conference included several tutorial sessions, forty-nine specialized oral presentation sessions, and five plenary addresses. Session topics included engine control and vehicle applications, neural image and speech processing, fuzzy and neuro-fuzzy techniques, and multi-media and web-based technologies.

Perhaps some of the most interesting presentations were in the field of medical and biological intelligent systems. Dr. Ronald Kates, from the Technical University München, Germany, demonstrated how his research uses neural networks to identify patients at high risk of breast cancer, which seems to be completely curable if caught at an early enough stage. Dr. Yuh-Jyh Hu of Tatung University, Taiwan, is using genetic algorithms to analyze biological gene combinations, which will enable scientists to better understand gene behaviour and the way that it changes over time. Together with the other papers in this session, these research programs demonstrate how intelligent techniques are likely to contribute to a better understanding of our own physiology, and thus hopefully an improved quality of life.

A more military application of intelligent systems was presented by Sheng Tang of the United States, who is using fuzzy techniques for fusion and clustering of data from multiple radar sensors for multi-target tracking. S. Lee and I. Kim of the Korean Maritime University demonstrated how their system uses a multi-variable fuzzy control system for automatic ship navigation in a dynamic environment, and several researchers presented interesting work in interactive media applications that would be very relevant to command and control operations.

Numerous presentations regarding image processing and pattern recognition were given, covering a wide range of methods and a variety of applications, from face recognition to synthetic aperture radar (SAR) target recognition. Although many methods proved quite effective, there seemed to be almost no universal theme to these studies, which implies that a single broadly applicable technique has yet to be developed. Rather, application-specific approaches are the current norm.

This annual conference will be held next year for the first time at Osaka-Kyoiku University in Osaka, Japan and Nara-Ken New Public Hall in Nara, Japan. The

increasing popularity of the conference, and the increasing maturity of intelligent systems, is sure to make it interesting.

Dr. Jay Howland
Physics and Energetic Materials

Conference: International Workshop on Dense Magnetized Plasmas, Kudowa Zdroj, Poland 12-14 Oct 00. Professor Marek Sadowski, Director of Andrzej Soltan Institute for Nuclear Studies and Dr. Marek Scholz, associate director of the Institute of Plasma Physics and Laser Microfusion co-organized the conference aimed at the introduction of new strategies, research and development results, and new technologies with special emphasis on production, processing and characterization of dense magnetized plasmas.

Plasma-Focus (PF) facilities are based on high-voltage high current discharges between two coaxial electrodes that produce a small cylindrical region of dense high temperature magnetized plasma. Many lectures were presented on the theoretical analysis of Z-pinch (the plasma is a short homogenous cylinder pinched by its own or an external magnetic confinement) discharges and also theoretical analysis of various phases of PF-type discharges. Several covered the latest experimental facilities and the recent experimental results of Z-pinch and/or PF type studies. A large portion of the talks and discussions was on the development of diagnostic methods for Z-pinch and PF experiments. A compact pulsed power generator was designed and constructed to drive an X (two crossed pinch regions usually from intersecting exploding wires) or Z-pinch load used as an intense point-like source of X-ray flash for backlighting diagnostics.

The application of LiF:Mg, Cu, P; LiF:Mg,Ti, and CaF2:Dy dosimeters for measurement of X-rays emitted from hot and dense plasmas was presented for the spectral range above 1 kev. One lecturer designed and built a wide-band high resolution X-ray spectrograph for 1.5-400 kev equipped with a Cauchois-Johansson crystal. A number of lectures were directed at new applications of Z-pinch and/or PF devices looking at the combined effects on a metallic sample irradiated by X-ray, high-energy ion beam and a hot plasma jet. An experiment was done to test the intensity of X-ray emission in the hard X-ray region from a Plasma Focus, in order to give a very profitable radiation source for medical and industrial fast radiography.

Lt. Col. Dave Burns
Astronautics

Site Visit: Tel Aviv University, Israel, August 24. Dr Joachim Joseph, professor of planetary physics, sponsored the visit. Tel Aviv University is active in the development of many electro-optical sensors, including MEIDEX, which is currently scheduled to be launched on the space shuttle (STS 107), June 18, 2001. This experiment will measure the slant visibility in dust storms. Aerosols cause vertical interference and atmospheric propagation effects cause horizontal interference in dust storms (in general). MEIDEX will use both the shuttle and an aircraft to measure UV and visible attenuation in both vertical and horizontal polarizations. Another goal of the program is to construct a general database on aerosols that may be able to be extended to cover other regions of the world.

Site Visit: Israel Military Industries (IMI) / Rocket Systems Division (RSD), near Tel Aviv, Israel, August 22. RSD has 4,500 employees and four operating units: rocket propulsion (energetic materials), rocket ordinance, pyrotechnics & countermeasures (e.g. flares), and material technologies. The material technologies unit contains a variety of programs including composite materials (e.g. bulletproof vests) and metal technologies. RSD has developed a computer program that predicts the shape and signature of rocket plumes at different altitudes and speeds as a function of nozzle and propellant design. The results that were shown indicate good agreement between predicted and measured data, particularly on predicting the hot phase points within the plume. Their rocket propulsion research is focused only on solid propellants. RSD is also developing a high temperature radiating database with IARD's technical support that will include the effects of turbulence and soot (particulates).

Site Visit: Israel Advanced Research & Development (IARD), Haifa, Israel, August 21. Dr Adam Devir (Chief Scientist) and the 15-person staff of IARD were

split off from the Technion two years ago. IARD focuses its research on radiometry, remote sensing, modeling & simulation, signature control, and environmental science. IARD has experience measuring the spectral radiance of high speed, short duration phenomenon (e.g. flares and rocket plumes), and also has developed a computer program to calculated the cloud-free line of sight (CFLOS) for an object in the earth's atmosphere. IARD is active in the Mediterranean/Israeli Dust Experiment (MEIDEX) that may be run on the space shuttle with an Israeli astronaut. This company makes simulators for fighter/missile EO signatures that can be pod-mounted on a small single engine aircraft. The pods can simulate trajectories over a 10-20^{o} field of regard. IARD has state-of-the-art equipment and facilities for producing and measuring complex (multiple wavelength), real-time (microseconds to minutes) optical signals.

Conference: The Advanced Optical Materials and Devices (ADOM-2) Conference at the Semiconductor Physics Institute (SPI), Vilnius, Lithuania, August 15-18. Much of the work in the microwave lab was centered on developing techniques for accurately measuring High Power Microwave (HPM) signals. Both S- and X-band waveguides were displayed with attached high power signal strength measurement equipment.

EOARD is funding two microwave-related SPI projects. The first is "Detection of wide frequency band microwave signals in ultra-wide dynamic range using a barrier-less semiconductor diode" and the primary investigator is Dr. Asmontas. The second is "Development of near-terahertz frequency GaN-based IMPATT diodes" and the primary investigator is Dr. Reklaitis. Dr. Gernot Pomrenke, AFOSR/NM, sponsored the second proposal. The SPI laser lab is being remodeled to accommodate a high power infrared laser (CO_2) that will be used to pump developmental organic dye lasers. SPI is seeking further support on their laser work in the areas of "Defect Engineering of Low-temperature Grown GaAs for Terahertz Radiation Applications."

Major Tim Lawrence
Space Technology

Meeting: Nanosatellite propulsion systems, University of Surrey, Guildford, United Kingdom, 12 October 2000. I traveled to Surrey to investigate a new proposal in propulsion systems for nanosatellite application. The proposal is shown in Figure 1 below. Mr. Malcolm Paul has designed a new type of resistojet that uses a long thin (1-mm) spiral heater inserted into a small tube. Based upon their previous experience, they plan to bend the heater and tube in a similar fashion inside the main architecture of the nanosatellite. From the diagram below, they plan on mounting the tank around the heater. The valve is shown on the outside with the nozzle on top. Future tests of this design are planned.

Figure 1

Meeting: Advanced propulsion work in Europe, London, 11 October 2000. The primary host and POC was Dr Anders Hansson, chief scientific advisor to Mr Mike Greer, MoD representative to the British National Space Centre. Dr Hansson discussed European advanced propulsion work, including a new program he heads being sponsored through the International Astronautics Federation investigating advanced propulsion for future interplanetary missions. All advanced energy concepts will be studied - anti-matter, nuclear, negative energy, advanced chemical, etc. in looking at the best alternatives for high-energy missions.

Site Visit: University of Surrey, Surrey Space Center, Guildford, United Kingdom, 14 September 2000. The primary host and POC was Dave Gibbon. Dr Mike Fife (AFRL/PRRS) was at Surrey to review the final work done on an EOARD contract investigating the endurance testing of a water resistojet. The final test results are shown in Figure 2. Dr Fife was also shown the recent research results looking into vortex flow hybrids, nitrous oxide mono-propellants, and low cost hydrogen peroxide bi-propellants.

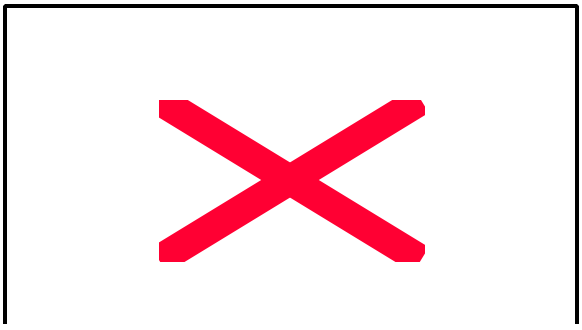


Figure 2

Meeting: Discussions of Hall thruster modeling collaboration, Universite Paul Sabatier, Toulouse, France, 10 – 13 September 2000. The primary host and POC was Dr Jean-Pierre Boeuf. The meeting discussed current AFRL research on 2D Hall thruster modeling and other ongoing electric propulsion research at Edwards AFB. Dr Bouef also presented his research on a similar 2D code. CNES gave a presentation on the flight diagnostic package for the upcoming Stentor mission, which will be flying 2 SPT - 100's and 2 PPS 1350's. Future collaboration is planned with Dr Boeuf on comparing the 2 models with the same data to improve their accuracy.

Meeting: BAE Systems advanced propulsion program, BAE Warton Airfield, Warton, England, 8 September 2000. The primary host and POC was Dr Ron Evans. The British Ministry of Defense, BAE Systems, and the British National Space Center are investing $400k through UK universities to investigate breakthrough propulsion concepts.

The University of Sheffield is studying an experiment conducted in 1992, when Podkletnov was able to levitate a spinning super-conducting disk when applying a 100 kHz magnetic field. The University of Sheffield researchers have not been able to replicate the experiment, but have discovered that Podkletnov did not conduct a detailed parametric analysis in his investigation. They plan on continuing this work to determine these parameters. Theoretical work is going on at the University of Lancaster, Dundee, and Glasgow.

Meeting: Starlabs advanced propulsion program, Brussels, Belgium, 6 - 7 September 2000. The primary hosts were Dr Chris van den Broeck and Dr Walter de Brouwer. Starlabs is a unique organization that uses private investment to conduct basic research. With a 70 person staff and an annual turnover of $90 million, they have received investment from Motorola, Nokia, Phillips, investment banks, charities, and others. They are conducting basic research in neurological simulation, mems, biotechnology, IT-ware, and advanced propulsion. Dr Sergey Krasnikov presented his theoretical research on traversable wormholes.

Meeting: Meet with ESTEC personnel on their advanced propulsion program, ESTEC, ESA, Noordwijck, the Netherlands, 5 – 6 September 2000. The primary host and POC was Dr Martin Tajmar. A combined EOARD/NASA group visited ESTEC to meet with the electric propulsion group and brief the NASA Breakthrough Propulsion Physics Program (BPP). The ESTEC personnel were very interested and said it matched well with their Propulsion 2000 study. They expressed interest in sponsoring a workshop along with EOARD and NASA next autumn after the release of this study. The objective of this workshop would be to invite European researchers with ideas in the BPP area to give talks and receive feedback from Mr Millis and others working in the program in the US.

ESTEC expressed an interest in EOARD's clean propellant program and we agreed to joint-host a conference in June 2001. The details will be announced in a future Eurogram.

CONFERENCE SUPPORT

EOARD promotes technical interchange by supporting and co-sponsoring technical workshops and mini-symposia at overseas conferences. We often receive, in return for sponsorship, proceedings and free conference registration for one or more Air Force representatives. Air Force R&D personnel attending or considering attending European conferences or seeking further details on the conferences listed below contact the program manager indicated (see footnotes). **Bi-service and tri-service support efforts** are in bold print.

Dates (2000)	*Location*	*Conference/Workshop Title*	*PM*[1]
19 - 23 Nov 00	Eindhoven, NL	EUROMECH Fluid Mechanics Conf www.efmc2000.tue.nl	CNR
11 - 12 Dec 00	**Birmingham, UK**	**Ti Alloys at Elevated Temp www.materials.org.uk**	**RSF**
12 - 15 Dec 00	Autrans, France	Biosensors, Biochips, & Nanobiotechnologies	DMB
20 - 23 Mar 01	Florence, Italy	4th Euro Conf on Turbomachinery, Fluid Dynamics and Thermodynamics www.ing.unifi.it/teeg/tmachinery/default.htm	CNR
20 - 25 May 01	Capri, Italy	Optimization in Composite Material Design and Structural Integrity	RSF
21 - 23 May 01	St. Petersburg, Russia	Mathematical Methods, Models and Architectures for Computer Networks	CR

Dates (2000)	*Location*	*Conference/Workshop Title*	*PM[1]*
		Security http://space.iias.spb.su/mmm2001	
28 - 29 May 01	Prague, Czech Rep	COIL R&D Workshop, Prague 2001	DMB
16 - 20 Jul 01	Univ of Huddersfield, UK	Algorithms for Approximation IV (A4A4) www.helios.hud.ac.uk/a4a4	CR
12 - 14 Sep 01	**Imperial College, London**	**A Conference on Capacity and Wake Vortices s.dalrymple@ic.ac.uk**	**CNR**

[1] CMS-Martin Stickley; CNR-Charbel N. Raffoul; CR-Chris Reuter; DMB- David M. Burns; GTO-Gerald T. O'Connor; JAH-Jay A. Howland; RR-Ron Reed; RSF- Robert S. Fredell; TL-Tim Lawrence

WINDOW ON SCIENCE

EOARD initiates and promotes technical liaison between Air Force and foreign scientists very effectively with the Window On Science (WOS) program, through which we can arrange and fund visits of foreign scientists to selected Air Force facilities. To nominate a WOS candidate, contact your Technical Director or your EOARD discipline representative. WOS visitors currently on contract are listed below. For further details contact the program manager indicated (see footnotes). **Bi-service and tri-service coordinated visits are in bold print.**

Dates (2000)	*Traveler*	*Country*	*Topic*	*Location(s) of Visit[1]*	*PM[2]*
2 - 8 Nov 00	M.Sc. David Roland Söderström	Sweden	Indium phosphide	AFRL/MLP, Wright-Patterson AFB, OH	DMB
2 - 8 Nov 00	Dr. Sebastian Lourdudoss	Sweden	Optoelectronic materials research	AFRL/MLP, Wright-Patterson AFB, OH	DMB
3 - 15 Nov 00	Professor Ryszard Pyrz	Denmark	Composite Micromechanics	Int'l Mech Engr Congress, Orlando FL, USAF Academy CO	RSF
4 - 15 Nov 00	Dr. Nicola Bonora	Italy	Modeling of very high strain rate plasticity	Hypervelocity Impact conference, Galveston TX AFRL/MN, Eglin AFB FL	RSF
10 - 18 Nov 00	Dr. Andrejs Krasnikovs	Latvia	Composite Mechanics	USAF Academy, CO	RSF
10 - 15 Nov 00	Dr. Constantinos Soutis	United Kingdom	Compressive strength of polymeric composites	USAF Academy CO	RSF
11 - 18 Nov 00	Dr. Louis Neil McCartney	United Kingdom	Composite Damage Mechanics	USAF Academy, CO	RSF
11 - 18 Nov 00	Professor Paul Smith	United Kingdom	Composite mechanics	USAF Academy CO	RSF
11 - 15 Nov 00	Dr. Pietro Milella	Italy	Modeling of very high strain rate plasticity	AFRL/MN, Eglin AFB FL	RSF
11 - 17 Nov 00	Dr. Willem Bles	The Netherlands	Spatial disorientation conference	AFRL/HE, Brooks AFB, TX	RR
11 - 15 Nov 00	Professor Dominique Thevenin	France	Vortex-Flame Interaction	AFRL/PR (WPAFB)	CNR
11 - 15 Nov 00	Professor Juan Carlos Rolon	France	Vortex-Flame Interaction	AFRL/PR (WPAFB)	CNR
11 - 17 Nov 00	Dr. Matthias A Hein	Germany	High Power Microwave Seminars	AFRL/SNHA, Hanscom AFB	DMB
11 - 16 Nov 00	Mr. Malcolm Paul	United Kingdom	Hydrogen peroxide storage and low-cost bi-propellant rocket systems	NASA Stenis Space Center, Gulfport, MS	TL
12 - 24 Nov 00	Dr. Otto Sensburg	Germany	Aeroelastic Models; Automated Design; All Moveable Fin	AFRL/VASD (WPAFB)	CNR
12 - 16 Nov 00	Dr. John Harlow	United	Hydrogen peroxide	NASA Stenis Space Center, Gulfport,	TL

Dates (2000)	*Traveler*	*Country*	*Topic*	*Location(s) of Visit*[1]	*PM*[2]
		Kingdom	storage and low-cost bi-propellant rocket systems	MS	
12 - 14 Nov 00	Professor Janis Varna	Sweden	Composite Mechanics	USAF Academy CO	RSF
16 - 22 Nov 00	Dr Martin Tajmar	Austria	SPT Diagnostics	NASA Goddard, MD MIT Boston, MA	TL
18 - 24 Nov 00	Professor Mikhail Kogan	Russia	Plasma Aerodynamics	4th Euromech Fluid Mechanics Conference, Eindhoven, NL	CNR
2 - 5 Dec 00	Mr. Paul Ford	United Kingdom	Micro-turbine jet engines	Munitions Directorate, Eglin AFB FL	RSF
2 - 5 Dec 00	Mr. James Dixon	United Kingdom	Micro-turbine jet engines	Munitions Directorate, Eglin AFB FL	RSF
1 - 5 Dec 00	Professor Yuly V. Milman	Ukraine	Advanced metals	Materials Directorate	RSF
2 - 9 Dec 00	Dr. Orest Ivasishin	Ukraine	Grain growth in alpha/beta titanium alloys	Thermech 2000 Conference Las Vegas NV	RSF
2 - 9 Dec 00	Dr. Roustam Kaibychev	Russia	Titanium and superplasticity	Thermech 2000 Conference Las Vegas NV	RSF
2 - 8 Dec 00	Professor Richard Pethrick	United Kingdom	Dielectric adhesive cure monitoring	Aircraft Structural Integrity Program conf, San Antonio TX	RSF
2 - 10 Dec 00	Dr. Olga Tikhomirova	Russia	Optical vortices	AFRL/DE at Wright-Patterson AFB, OH	DMB
4 - 9 Dec 00	Dr. Marc Monthioux	France	Carbon carbon composites	AFRL/MLBC, Wright-Patterson AFB OH	RSF
5 - 10 Dec 00	Dr. Blaga Iordanova	United Kingdom	Agent-Based Decision Support and Information Systems for Air Traffic Management	AFRL/IFT, Rome, NY	CR
10 - 18 Dec 00	Mr. Ivan Tiuokine	Russia	Adaptive Control with RBF Neural Networks	2000 IEEE Conference on Decision and Control	CR
14 - 20 Dec 00	**Dr Ilia M. Chertok**	**Russia**	**Bright chains of structures in the solar corona**	**Fall AGU Meeting**	**DMB**
6 - 13 Jan 01	**Dr. Yury F. Kolesnichenko**	**Russia**	**Investigation of AD-body Interaction with Microwave Discharge Region in Supersonic Flows**	**AIAA; Reno, NV**	**CNR**
6 - 13 Jan 01	**Dr. Serguei Leonov**	**Russia**	**Plasma Influence on Characteristics of Aerodynamic Friction and Separation Lines Location**	**AIAA; Reno, NV**	**CNR**
6 - 13 Jan 01	**Dr. Evgueni Cheikine**	**Russia**	**Scramjet with MHD Control under 'AJAX' Concept.**	**AIAA; Reno, NV**	**CNR**
6 - 13 Jan 01	**Dr. Alexander Kuranov**	**Russia**	**Scramjet with MHD Control under 'AJAX' Concept.**	**AIAA; Reno, NV**	**CNR**
8 - 20 Jan 01	Dr. Dieter Sporn	Germany	High-performance oxide fibers	AFRL/ML, Wright-Patterson AFB OH; NASA Glenn, Cleveland OH; 3M, Minneapolis MN	RSF
27 Jan - 6 Feb 01	Dr William A Clarkson	United Kingdom	Diode-pumped solid state lasers	AFRL/DELO, Kirtland AFB, NM, and AFRL/SNJT, Wright-Patt AFB, OH.	DMB
3 - 8 Feb 01	Dr Rafal Zbikowski	United Kingdom	Micro Air Vehicle (Control and Structure)	AFRL/VAAC; WPAFB; AFOSR (D.C.)	CNR

Dates (2000)	*Traveler*	*Country*	*Topic*	*Location(s) of Visit*[1]	*PM*[2]
3 - 8 Feb 01	Dr Brian White	United Kingdom	Micro Air Vehicle (Control and Structure)	AFRL/VAAC; WPAFB; AFOSR (D.C.)	CNR
4 - 10 Feb 01	Derek Fray	United Kingdom	New techniques for Titanium extraction	AFRL/ML, Wright-Patterson AFB OH	RSF
12 - 8 Feb 01	Dr. Elca Touitou	Israel	Autoradiography quant. techniques for exposure to fuels and solvents	AFRL/HEST, Wright-Patterson AFB, OH.	

[1] AFRL Research Sites–**ARS**: Armstrong Research Site, Brooks AFB, TX; **ERS**, Edwards Research Site, Edwards AFB, CA **HRS**: Hanscom Research Site, Hanscom AFB, MA; **PRS**: Philips Research Site, Kirtland AFB, NM; **RRS**, Rome Research Site, Rome, NY; **WRS**: Wright Research Site, Wright-Patterson AFB, OH; Other sites: **AEDC**: Arnold Engineering Development Center, Arnold AFB, TN; **USAFA**: Air Force Academy, Colorado Springs, CO; **ARL**: Army Research Laboratory

[2] CMS-Martin Stickley; CNR-Charbel N. Raffoul; CR-Chris Reuter; DMB-David M. Burns; GTO-Gerald T. O'Connor; JAH-Jay A. Howland; PJO-Peter J. Ouzts; RR-Ron Reed; RSF-Robert S. Fredell; TL-Tim Lawrence

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